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ABSTRACT

This study assessed the effects of Instrumental Enrichment (IE) instruction with minority students on a non-verbal measure of students' intelligence (the Progressive Matrices test), on students' report card marks, and on students' City-Wide Test nationally-normed reading and mathematics scores in the School District of Philadelphia (Pennsylvania). Seven teachers who had been trained in IE techniques and taught fifth grade through seventh grade selected one of their classes to participate in the study. Two of the selected classes served special education students. The study shows that: (1) students in classes that had more IE sessions scored higher on the Progressive Matrices test than did students in classes that had fewer sessions; (2) for special education students, Progressive Matrices scores improved, but at a slower rate than did regular education students' scores; (3) up to about 30 IE sessions improve regular education students' English, reading, science, and social studies report card marks, but a larger number of sessions may have interfered with attainment; and (4) national-norm based City-Wide Test scores in reading/English/language arts and mathematics were lower for regular-education students in classes that had more IE sessions than others. An appendix contains experimental design details and data analyses. (JB)

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ED 361 462

The School District of Philadelphia

A Study of the Effects of Instrumental Enrichment on Middle-Grade, Minority Students

Report No. 9225

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A Study of the Effects of Instrumental Enrichment on Middle-Grade, Minority Students

Report No. 9225

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April 1992

EXECUTIVE SUMMARY

The goals of this study are to assess the effects of the Instrumental Enrichment (IE) on the following indices of student achievement: (a) a non-verbal measure of students' intelligence, the Progressive Matrices test, (b) students' report card marks and (c) students' City-wide Test nationally-normed reading and mathematics scores.

Seven teachers who had been trained in Instrumental Enrichment (IE) techniques and taught fifth grade through seventh grade selected one of their classes to participate in a study of the value of IE materials and instruction. Two of the selected classes served special education students.

The study showed that the value of IE for improving student attainment differed markedly for the three types of outcomes. The findings were: (a) students in classes that had more IE sessions scored higher on Progressive Matrices tests than students in classes that had fewer sessions; (b) special education students' Progressive Matrices scores improved, but at a slower rate than regular education students' scores; (c) up to about 30 IE sessions improve regular education students' English, reading, science and social studies report card marks, but a larger number of sessions may have interfered with attainment; and (d) national-norm based City-wide Test scores in Reading/English/Language Arts and mathematics were lower for regular-education students in classes that had more IE sessions than others. The City-wide Tests are equated to the Comprehensive Tests of Basic Skills Form U.

IE is an educational program that is designed for two or more years of instruction. However, this evaluation showed that statistically reliable outcomes can be produced in much shorter periods of time. The improvement in Progressive Matrices test scores was produced over four months. The other program effects were the result of less than a year of IE instruction.

These findings suggest that IE is a valuable instructional activity but, that supplanting other instructional activities with IE appears to have some costs. It is hypothesized that the costs derive from students' failing to develop the conceptual bridges needed to apply IE concepts to achievement tests.

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INTRODUCTION

This is a study of the effects of Instrumental Enrichment on fifth to seventh grade students, principally of Latino and African American backgrounds. The study was guided by eleven research questions. The questions were:

1. What is Instrumental Enrichment (IE)?

2. What benefits to students is IE believed to provide?

3. What training was provided to IE teachers?

4. Who participated in the study?

5. What data were obtained for the study?

6. What were the experimental design and the data analysis methods of the study?

7. What did visits to the classroom show?

8. What did the Progressive Matrices tests show about the IE program?

9. What did English/language arts, reading, mathematics, science and social studies report card marks show about the IE program?

10. Did IE improve students' scores on the nationally normed portions of the spring Philadelphia City-wide Tests: Reading/English/Language Arts, Mathematics Computation, and Mathematics Concepts and Applications?

11. What can be concluded from this study of IE?

The report consists of two parts. The first part is a chart essay containing answers to these questions. The second part is an appendix that contains details about the experimental design and data analyses.

The chart essay was chosen for the body of the report because it is a "user-friendly" technique for presenting information. IE links research questions to policy issues while communicating effectively with various audiences. The appendix was included for readers who wish to examine the data and numerical analyses that are the sources of the information in the chart essay.

1. What is Instrumental Enrichment (IE)?

Instrumental Enrichment is a two to three year curriculum designed to help adolescent students develop independent, higher level thinking skills. It complements traditional middle school language arts, mathematics, science and social science curricula by emphasizing reasoning skills that underlie them all.

- IE is based on Reuven Feuerstein's theory that the skills measured by intelligence tests can be taught and are generalizable; i.e. that "learning to learn" is a viable construct. Feuerstein is Director of the Hadassah-Wizo-Canada Institute, Jerusalem. His work is an outgrowth of Jean Piaget's studies of cognitive development.

- The curriculum consists of instructional "instruments" developed by Feuerstein. Each "instrument" consists of several paper and pencil problem-solving activities.

- Organization of Dots, Orientation in Space, Comparisons, and Analytic Perceptions are the instruments that comprise the first level instructional package. These instruments were provided to classes participating in the study.

- Each activity leads the student through an information-gathering phase, an information-use phase, and a solution-expression phase.

- The materials attempt to be culture fair by emphasizing the use of patterns and spatial orientations, and by limiting the reading required of the student.

- Teachers who use IE are trained to help students by mediating between what the student can do and the material that the student must learn. The teacher uses the student's initial performance to lead him/her through activities that engage higher level cognitive processes, such as the application of rules and analogies.

- Teachers are expected to relate or "bridge" IE's higher level cognitive processes to traditional school subjects.

2. What benefits to students is IE believed to provide?

According to information disseminated by Curriculum Development Associates, distributor of the IE instructional materials, the program is designed to achieve the following objectives:

- To correct deficiencies in cognitive development.
- To change students from passive recipients of information to confident, active, successful learners.
- To improve students' standardized test scores.

3. What training was provided to IE teachers?

- The Chief of the Pennsylvania Division of School Equity recruited participants for IE training by:
  - Securing agreement of two District Superintendents and
  - Disseminating information to principals and other staff at sub-district meetings. The principals then recruited teachers at their school.

- Fifty-five teachers and principals from eleven District 4 and District 5 schools participated in IE training programs in 1989-90. Psychologists and supervisory staff of the subdistricts participated as well.

- The training programs were managed by the Pennsylvania Department of Education, Division of School Equity. They were conducted by Curriculum Development Associates of Washington DC, publisher of the instructional materials.

- According to information provided by Barbara Smith, Chief of the Pennsylvania Division of School Equity, the training consisted of two staff development programs of five days each, conducted one school year apart.
  - The first staff development program emphasized the content of the four Level 1 instruments of the IE instructional sequence. The second program emphasized the content of the Level 2 instruments of the IE sequence.
  - The training was experiential. It emphasized preparing and conducting demonstration IE lessons. Role playing was used to give participants an opportunity to practice what was taught.
  - The theory of mediated instruction, and the organization of a school to facilitate and support mediated instruction were discussed.
  - Teachers in the project participated in the first staff development program during the school year before the study. They participated in the second staff development program during the school year in which the study was conducted.

4. Who participated in the study?

- In December 1990, all 55 teachers who were trained in 1989-90 were asked to volunteer for the study. Nine teachers volunteered, and seven of these teachers participated fully in the study.

- Participating teachers each chose an experimental class before study began. The classes served students who were in fifth through seventh grade or who were in special education classes in the same grade range.

- Three Research for Better Schools (RBS) staff members who had been trained in IE pretested and posttested a sample of students with the Progressive Matrices tests. They coached a subsample of the students on test-related skills prior to posttesting. In addition, RBS staff members observed IE instruction in several classrooms where they had administered the tests.

- A total of 161 students, principally of Latino and African American backgrounds, were enrolled in the classes that participated fully in the project. Twenty-nine of the students were in two special education (mixed category, mildly handicapped) classes.

5. What data were obtained for the study?

- The Standard Edition of the Progressive Matrices test (J. C. Raven, The Psychological Corporation, 1938) was used to assess the value of IE for correcting deficiencies in cognitive development.
  - Progressive Matrices is a non-verbal test of intelligence that emphasizes abstract reasoning. The test items require discovering the rules underlying geometric patterns.
  - The pretest was administered to 73 students sampled from the nine experimental classes. When students who were absent for the second testing and classes that were dropped from the study were eliminated, a sample of 47 students evenly distributed among seven classes remained.
  - The pretests were given in March and April 1991; the posttests were given in May and June 1991. The intervals between pretesting and posttesting and the frequencies that teachers engaged students in IE instruction differed among the experimental classes. As a result, the effect of IE on Progressive Matrices scores could be measured over this short period of time.
  - Prior to posttesting, two students per class were coached on taking the Progressive Matrices test to see whether this procedure increased the sensitivity of the test to the effects of IE. The project staff postulated that, because coached testing followed the instructional pattern of IE, it might be able to detect growth better than uncoached testing.
  - Students were pre- and posttested by Research for Better Schools staff members.

- June 1990 and June 1991 report card marks in English/language arts, reading, mathematics, science and social studies were used to measure the effect of IE on students' becoming successful learners in the eyes of their teachers.
  - Letter grades appearing on the report cards were turned into a numerical scale similar to the scales used for computing grade-point averages, i.e., A=4, B=3, etc.

- Spring 1990 and Spring 1991 City-wide Tests, which are equated to the Comprehensive Tests of Basic Skills Form U published by CTB Macmillan/ McGraw Hill, were used to measure the effect of IE on students' performance on a nationally normed measure.
  - Normal Curve Equivalent (NCE) scores based on the publisher's national-norms were used for this study.
  - Reading/English/Language Arts, Mathematics Concepts and Applications, and Mathematics Computation scores were used. These are the three nationally-normed sections of the City-wide Tests.

- Teacher questionnaires were used to identify the students in the study, record the amount of IE instruction that classes received, and record the IE teaching instruments that were used with the students.

- Classroom observations provided contextual information: characteristics of the classes, teaching techniques used, students' responses, instructional content and activities, and teachers' reactions to the training that they had received.

6. What were the experimental design and the data analysis methods of the study?

- The study was based on the assumptions that there would be naturally occurring variation in the number of occasions that experimental classes would have IE instruction, and that more IE sessions would result in greater student gains in Progressive Matrices test scores, report card marks and nationally normed City-wide Test scores.

- The evaluation strategy was to relate the amount of students' exposure to IE sessions to the three types of measures of student attainment.

- Regression analyses relating the number IE sessions to the outcome variables were used to evaluate the data. This technique was used in lieu of experimental group-control group comparisons because there were many teachers who did not volunteer for the study, but who had been trained in IE and had received IE materials. Thus many students in the potential control group could have had undocumented IE instruction when they were taught by the trained teachers.

- Pre-values of the student attainment measures (Progressive Matrices test scores, report card marks and City-wide Test scores), grade level, and participation in special education, were used to distinguish pre-existing individual differences among students from the effects of IE. Sometimes, specialized forms of the pre-values, such as the square of the pre-value or products of two pre-values, were used to explore effects which were strong initially but then diminished (curvilinear effects) or to explore the ways that IE effected student subgroups (interaction effects).

7. What did visits to the classroom show?

- In order to evaluate the quality of the IE instruction, six of the nine classes that began the project were each observed once by Research for Better Schools staff. The observations were recorded on monitoring forms. The RBS staff also visited every class room twice to administer Progressive Matrices tests.

- When observed, all of the classrooms were engaged in activities using published IE instruments: four classes were using Comparisons, one class was using Organization of Dots and one class was using both these instruments.

- Instructional style was judged to be chiefly teacher centered in four of the six observed lessons. Student- centered discussion was the principal activity during one observed lesson; teacher-centered discussion followed by independent student work was found in the other lesson.

- Observers reported that the teachers tended to treat IE as a self-contained activity, with only limited bridging to the rest of the curriculum. Ways that IE concepts could be applied to other, more traditional classroom activities were not adequately developed during the observed IE lessons.

8. What did the Progressive Matrices tests show about the IE program?

The average number of IE sessions between Progressive Matrices pretesting and posttesting was 14.8. During this period the average score went from 31.3 to 34.4 raw score points, an average gain of 3.10. Regression analysis of the Progressive Matrices tests showed several statistically reliable trends:

- Regular education students' scores were increased as a result of participating in IE sessions. The more sessions the students participated in, the higher their posttest scores when the effects of other variables (pretest score, coaching and special education participation) were removed.

- Special education students' scores on this measure probably increased less than regular students' scores. This finding is provisional because the special education students had more IE sessions than any regular students, making it impossible to separate the effect of IE from the effect of having been designated special education.

- Coaching improved the scores of students with low Progressive Matrices pretest scores more than the scores of students with high pretest scores. However, coaching students did not improve the ability of the Progressive Matrices test to detect the effects of IE.

(See pages 17 and 18 for the data analysis.)

9. What did English/language arts, reading, mathematics, science and social studies report card marks show about the IE program?

The five regular education classes had consistently reported end-of-year letter-grade report card marks, but the special education classes did not. (Special Education student evaluations are based on individualized education plans or IEPs.) For this reason, the analyses of marks are only for the 115 students who were in regular classes.

- IE improved report card marks in four subjects, English/language arts, reading, science and social studies. The improvement was evident once the effects of general trends in the school district were controlled.
  - .. In grades four to seven of the School District of Philadelphia, as the grade level increases the percentage of students earning As, Bs and Cs decreases. (City-Wide Summary of Report Card Marks, Third Report Period, 1990-91.)
  - .. IE students showed less of the decline typically found in these subjects in the school district.

- IE sessions at the beginning of the program were more effective than the later ones.
  - .. Twenty-one to 35 IE sessions moderated the decline in marks in the four subjects.
  - .. One class had more than 35 IE sessions. IE affected students' marks less in this class than in the classes that had fewer sessions.

- IE did not affect students' Mathematics marks.

(See pages 18 to 20 for the data analyses)

10. Did IE improve students' scores on the nationally normed portions of the Spring Philadelphia City-wide Tests: Reading/English/Language Arts, Mathematics Computation, and Mathematics Concepts and Applications?

The normal-curve equivalent (NCE) test scores of the five regular education classes in the study were examined for this question. Special education classes were excluded because they did not participate in the City-wide Testing program.

- Participation in IE did not improve students' test scores.

- Participation in more IE sessions was associated with lower City-wide Test national NCE scores i.e., the larger the number of IE sessions, the lower the scores.

(See pages 20 and 21 for the data analyses.)

11. What can be concluded from this study of IE?

The study suggested that IE was successfully implemented as an instructional activity in middle-school grades in two sub-districts with minority student enrollments. However, bridging the concepts and skills of IE to other traditional aspects of the grade five to grade seven instructional program was not emphasized. As a result, the project goals of improving abilities test scores and marks were attained, but only at the expense of another desirable goal, improving norm-referent City-wide Test scores.

Gains attributable to the program were obtained on the Progressive Matrices test, even though only a few months separated the pretesting and the posttesting. As the Progressive Matrices test is an instrument that is close to IE in the demands it makes on the test taker, only minimal bridging between IE concepts and content of the test is required for IE to produce pre-to-post improvements in the students' test scores.

Clear gains were also obtained for report card marks in English, reading, science, and social studies. These marks reflect class work that proceeds at a pace that permits students to reason their work out carefully. In this environment, students are believed to be able to extend the concepts learned in IE to their class work without having been taught systematically about bridging.

It is hypothesized that students also attempted to make their own bridges between the concepts developed in IE and standardized achievement test content, but failed. Because bridging did not appear to be dealt with adequately in the IE instruction, the students had to make the attempt while experiencing the stresses of being tested. Making the attempt under these conditions proved to be dysfunctional, and resulted in lower test scores. If this hypothesis is valid, research should show that the effect of IE on standardized achievement test scores is related to the extent that teachers emphasized bridging during IE instruction.

This evaluation was much shorter than the two to three years that the full IE curriculum requires. One possible explanation for the observed lack of emphasis on bridging may be that bridging does not emerge fully until students have been engaged in IE for a longer time. If this hypothesis is valid, then future research should show that bridging and its effects are evident after students have had more than one school year of IE.

The improvements in students' marks and Progressive Matrices scores show that IE is a useful procedure for meeting some of the needs of Latino and African American students enrolled in grades five to seven. The negative standardized test outcomes and observations about bridging suggest that the value of IE instruction will be more apparent in multi-year studies which attend to the bridging process.

APPENDIX

TECHNICAL INFORMATION AND REGRESSION ANALYSIS TABLES

This appendix has been included for readers who wish more detail regarding the experimental design and data analyses that yielded the findings. The information presented relates to Study Question 6, which deals with the experimental design and data analysis procedure used to evaluate the effects of IE on three kinds of student achievement measures. It is also related to Study Questions 8 through 10 which describe the program's effects on these measures.

The data were analyzed using multiple regression models. The purpose of this statistical procedure is to explain an outcome's relationship to its possible causes, which are called "predictors." It is capable of isolating the effect of one predictor on the outcome from the effects of the other predictors in a model.

General Model. A separate regression model was used for each outcome variable. These models had a common form that included the amount of IE instruction and a pre-IE value of the variable of interest. Other outcome variables were included in each model as applicable. The models are of the general form:

Outcome = B1*(Pre-Value)
+ B2*(No. of IE Sessions)
+ B3*(Additional Variable 1)
+ B4*(Additional Variable 2)
+ Constant.

The "B-weights" or regression weights in the model, B1, B2, etc., show the effect of their associated predictor variables on the outcome. When the effect is more than mere chance, the regression weights are statistically significantly different from 0, that is, the odds of the true value of a weight being zero is less that five in a hundred. Regression weights may be positive or negative, depending upon the direction of the relationship between an outcome and a predictor.

The B-weights represent trends that are evident when the effects of all the other variables in a regression model have been removed by statistical means. For example, a significant B-weight for the variable Number of IE Sessions means that this variable has an effect on the outcome. However, the effect might not have been evident until the effects of the students' pretest scores and other variables were removed.

In addition to B-weights, each data analysis contains a Constant, the theoretical value that would be obtained if the Pre-value, the Number of Sessions, and the Additional Variables for students were all zero. As this zero condition cannot exist in this study, the value of the constant is not meaningful.

VARIABLES

The Outcome in the general form of the regression model is a student's Progressive Matrices score, mark, or City-wide Test score at the end of the period of the study. With regard to the predictors:

. Pre-Value is the student's Progressive Matrices score, mark, or City-wide test score at an earlier date.

. Number of IE Sessions is the number of times that the teacher reported providing IE instruction to the student's class between the collection of the Pre-value and the Outcome data.

. Additional Variables, are background characteristics, interaction terms, and/or curvilinear terms that proved to be valuable in describing the Outcome.

FINDINGS

Progressive Matrices Tests. Table 1 shows the regression analysis of Progressive Matrices test scores.

TABLE 1

THE EFFECT OF INSTRUMENTAL ENRICHMENT ON PROGRESSIVE MATRICES POSTTEST SCORES

Variable	B-weight
Pretest Score	.60158*
No. of IE Sessions	.42644*
Coaching (Yes or No)	15.69365*
Coaching-Pretest Interaction	-.37658*
Special Education (Yes or No)	18.13875*
Special Education-Sessions Interaction	-1.17402*
Constant	10.97664
Variance explained	64%
Average pretest to posttest change	3.1 items

* $p < .05$

The B-weights and constant of the prediction model, the percent of variance explained and the average change in the score are displayed. The regression model in the table explained 64% of the variance, which means that it was moderately good at describing the outcome, the posttest Progressive Matrices scores.

All predictor variable effects in the analysis were statistically significant. The positive B-weight for Pretest Score showed that students who had high scores on the pretest also tended to score highly on the posttest, an indication that the test was reliable.

The positive B-weight for the variable Number of IE Sessions showed that students who participated in more sessions had higher scores, once the effects of the other variables in the analysis were removed. This B-weight shows that Progressive Matrices scores were improved by IE.

The positive B-weight for the variable Coaching and the negative B-weight for the Coaching-Pretest Interaction together show that coaching improved the scores of students who had low pretest scores more than it improved the scores of students with high pretests.

The positive B-weight for Special Education and the negative B-weight for the Special Ed.-Sessions Interaction cannot be interpreted in the same manner as other main effect-interaction combinations because the Special Education classes had more IE sessions between the pretesting and the posttesting than other classes. For this reason, it is likely that these variables merely describe a lower skills acquisition rate for Special Education classes.

Several other analyses of Progressive Matrices scores were tried. None had greater predictive value and none showed that coaching improved the sensitivity of the test to the effect of IE, one of the notions raised when the study was planned.

Marks: Five regression analyses of students' report card letter-grade marks are shown in Table 2. There is a separate analysis for each subject, English language arts, reading, science, mathematics and social studies. As five different subjects were analyzed, the B-weights and other, related data for each subject are listed in a column on the table. The analyses are of regular students' marks because there were no special education students who received marks in these subjects for two consecutive years.

TABLE 2

THE EFFECT OF INSTRUMENTAL ENRICHMENT ON STUDENTS' REPORT CARD MARKS

Variable	Subject				
	Language Arts	Reading	Math	Science	Social Studies
Control: Grade	0.7250*	0.2714	0.0752	0.6650	0.2817
June '90 Mark	0.7729*	1.2862	1.1706*	1.3995*	1.0114*
Square of June '90 Mark	-0.0618	-0.1479	-0.1038	-0.1519	-0.0677
Effects of IE: No. of Sessions	0.3818*	0.3220*	-0.1529	0.3404*	0.1925*
No. of Sessions Square	-0.0050*	-0.0040*	0.0012	-0.0046*	-0.0023*
Constant	-9.7865	6.6764	4.4702	-9.2240	-3.7730
Variance explained	37%	17%	41%	32%	15%
No. of IE sessions at turning point	38	39	n.a.	36	40
Average change in marks	-0.50	-0.53	-0.29	-0.21	-0.04

* $p < .05$

The five analyses were identical in their structure. They differed only in the outcome variable being analyzed. They have weak to moderate explanatory power, explaining 15% to 41% of the marks' variation. Pre-existing student characteristics were controlled statistically by including three variables in each analysis: Grade in 1991, June 1990 Mark, and the curvilinear variable, Square of June 1990 Mark. These variables control some of the non-programmatic influences on marks, but are not otherwise of interest. In each analysis, exposure to IE instruction is measured by two variables, Number of IE Sessions and Number of IE Sessions Squared. The inclusion of the squared terms showed that the relationships between the number of IE sessions and students' marks grew to a peak and then declined.

For four of the marks, language arts, reading, science and social studies, there are large, positive, statistically reliable effects for the variable Number of Sessions, and small, negative, statistically reliable effects for Number of IE Sessions Squared variable. Together, these variables describe achievement patterns that grow to peaks at 36 to 40 IE

For four of the marks, language arts, reading, science and social studies, there are large, positive, statistically reliable effects for the variable Number of Sessions, and small, negative, statistically reliable effects for Number of IE Sessions Squared variable. Together, these variables describe achievement patterns that grow to peaks at 36 to 40 IE sessions and then decline. This finding may show that many IE sessions interfere with learning the skills reflected in marks. However, as only one class had more than 40 sessions, the decline may merely be an artifact of something unique about this class.

In contrast to the other subjects, for mathematics marks, neither the Number of IE Sessions nor the Number of IE Sessions Square was significant, suggesting that these marks were not affect by IE.

City-wide Test Scores: Three related analyses of City-wide Test scores, one for each subtest, are shown on Table 3. The analyses shown in the table are identical in their construction, differing in the test score being analyzed: Reading/English/Language Arts, Mathematics Computation, or Mathematics Concepts and Applications. Only regular education students are included in the analyses shown on the table because Special Education students were not tested.

TABLE 3

THE EFFECT OF INSTRUMENTAL ENRICHMENT ON SPRING 1991
CITY-WIDE TEST NORMAL CURVE EQUIVALENT TEST SCORES

Variable	Read./Eng. Lang. Arts	Mathematic Computation	Mathematics Concps. & Appls.
Control:			
Grade in 1991	15.0558*	35.8501*	19.9893*
Spring '90 Score	.5709*	.3959*	.6133*
Effect of IE:			
No. of Sessions	-.2054*	-.4636*	-.2094*
Constant:	-66.5505	-155.564	-94.5049
Variance explained:	43%	44%	43%
Average change in NCE:	-3.86	9.61	-2.79

*$p < .05$

The analyses had moderate explanatory power, accounting for 43% or 44% of the variation in test scores. Differences among students that were not expected to be related to IE were controlled through statistical means by including two variables, Grade in 1991 and Spring 1990 Score on the subtest. (Curvilinear terms and interactions were not used in the City-wide Test score analyses because they did not provide useful information, and they masked the statistically significant effects that were found.)

The negative, statistically significant effect for the variable Number of Sessions shown in each of the analyses suggests that increased IE instruction is related to poorer performance on the three City-wide Test scores. It is hypothesized that students' poorly developed bridging skills interfered with the students' attaining higher test scores.